CLAIMS

Having described the preferred embodiments, the invention is now claimed to be:

1. A magnetic field gradient coil for a short-bore magnetic resonance imaging scanner, the gradient coil comprising:

upper and lower magnetic field gradient coil windings **(70, 72, 74, 76, 102, 104, 112, 114)** that define a subject-receiving bore **(44)** and which generate transverse magnetic field gradients imposed on an associated static magnetic field generally oriented in a longitudinal direction through the bore, the upper gradient coil winding **(70, 74)** having an arcuate curvature (C_{upper}) transverse to the longitudinal direction and a longitudinal length (L_{upper}) in the longitudinal direction that is smaller than a longitudinal length (L_{lower}) of the lower gradient coil winding **(72, 76)**.

2. The gradient coil as set forth in claim **1**, further including:

a coil support including an upper section **(40)** supporting the upper magnetic field gradient coil winding **(70, 74)** and a lower section **(42)** supporting the lower magnetic field gradient coil winding **(72, 76)**.

3. The gradient coil as set forth in claim **2**, wherein the upper and lower magnetic field gradient coil windings **(70, 72, 74, 76)** include:

primary coil windings **(70, 72)** disposed on coil bore-defining surfaces **(52, 56)** of both the upper and lower sections **(40, 42)** of the coils support; and

shield coil windings **(74, 76)** disposed on outer surfaces **(50, 54)** of both the upper and lower sections **(40, 42)** of the coils support.

4. The gradient coil as set forth in claim **3**, further comprising:

connecting conductors **(82)** extending across an edge **(62)** of the lower section **(42)** between the coil bore-defining surface **(56)** and the outer surface **(54)**, the connecting conductors **(82)** electrically connecting the primary and shield coil windings **(72, 76)**.

5. The gradient coil as set forth in claim **1**, wherein::

the arcuate curvature of the upper gradient coil windings **(70, 74)** lies generally along a portion of a circular or oval cross-section; and

the lower gradient coil windings **(72, 76)** include primary windings **(72)** that are substantially planar compared with the arcuate curvature (C_{upper}) of the upper gradient coil windings **(70, 74)**.

6. The gradient coil as set forth in claim **5**, wherein the lower gradient coil windings **(72, 76)** further include

shield coil windings **(76)** lying generally along an arcuate curvature matching the arcuate curvature (C_{upper}) of the upper coil windings **(70, 74)** such that the upper gradient coil windings **(70, 74)** and the shield coil windings **(76)** of the lower gradient coil windings **(72, 76)** have one of a circular cross-section and an oval cross-section.

7. The gradient coil as set forth in claim **6**, wherein the upper coil windings **(70, 74)** further include:

primary coil windings **(70)** and shield coil windings **(74)** each defining curved surfaces having the arcuate curvature (C_{upper}), the defined curved surfaces being spaced apart a separation distance transverse to the longitudinal direction;

connecting conductors **(80)** disposed at longitudinal ends of the upper coil windings **(70, 74)** and electrically connecting the primary coil windings **(70)** and the shield coil windings **(74)** by spanning the separation distance along a flared annular connecting surface **(60)** having an angle other than 90° respective to the longitudinal direction.

8. The gradient coil as set forth in claim **1**, wherein the longitudinal length (L_{upper}) of the upper gradient coil windings **(70, 74)** is about the same as or less than a dimension of the coil bore **(44)** transverse to the longitudinal direction.

9. The gradient coil as set forth in claim **8**, wherein a ratio of the longitudinal length (L_{upper}) of the upper gradient coil windings **(70, 74)** to the dimension of the coil bore **(44)** transverse to the longitudinal direction is less than or about 0.7.

10. The gradient coil as set forth in claim **1**, wherein the magnetic field gradient coil windings **(70, 72, 74, 76)** include:

a first sub-set of the windings that when energized produce a first magnetic field gradient oriented transverse to the longitudinal direction and parallel to a plane of bilateral symmetry **(58)** of the gradient coil windings **(70, 72, 74, 76)**; and

a second sub-set of the windings that when energized produce a second magnetic field gradient oriented transverse to the longitudinal direction and transverse to the plane of bilateral symmetry **(58)** of the gradient coil windings **(70, 72, 74, 76)**.

11. The gradient coil as set forth in claim **10**, wherein the first magnetic field gradient has a zero-field point **(86)** displaced toward the upper gradient coil winding **(70, 74)** relative to an imaging volume **(16)** that is surrounded by the gradient coil.

12. The gradient coil as set forth in claim **1**, wherein the magnetic field gradient coil windings **(102, 104, 112, 114)** include:

a first sub-set **(102, 104)** of the windings that when energized produce a magnetic field gradient **(106)** in a first direction oriented transverse to the longitudinal direction and at a 45° angle to a plane of bilateral symmetry **(58)** of the gradient coil windings **(70, 72, 74, 76)**; and

a second sub-set **(112, 114)** of the windings that when energized produce a magnetic field gradient in a second direction transverse to the longitudinal direction and transverse to the first direction.

13. A magnetic resonance imaging scanner comprising:

a housing **(10)** having: (i) an imaging volume **(16)** imaged by the scanner and (ii) an imaging subject support section **(20)** disposed below the imaging volume **(16)**, the imaging subject support section **(20)** extending beyond a length (L_{bore}) of a magnet bore;

a radio frequency coil **(28)** arranged to inject a radio frequency signal into the imaging volume **(16)**; and

a magnetic field gradient coil **(30, 100)** including a lower section **(42)** disposed in the imaging subject support section **(20)** of the housing **(10)** and an upper section **(40)** that together with the lower section **(42)** define a coil bore **(44)** containing the imaging volume **(16)**, the upper section **(40)** having an arcuate curvature (C_{upper}) and coil windings **(70, 74)** spanning a first length (L_{upper}), the lower section **(42)** having coil windings **(72, 76)** spanning a second length (L_{lower}) greater than the first length (L_{upper}).

14. The imaging scanner as set forth in claim **13**, wherein the coil windings **(70, 72, 74, 76)** of the magnetic field gradient coil **(30)** include:

a first set of windings that when energized produce a vertical magnetic field gradient imposed on an associated generally horizontal magnetic field at least in the imaging volume **(16)**.

15. The imaging scanner as set forth in claim **14**, wherein the vertical magnetic field gradient has a zero-field point **(86)** displaced vertically upward relative to the imaging volume **(16)**.

16. The imaging scanner as set forth in claim **14**, wherein the magnetic field gradient coil windings **(70, 72, 74, 76)** further include:

a second set of windings that when energized produce a horizontal magnetic field gradient imposed on the associated generally horizontal magnetic field at least in the imaging volume **(16)**.

17. The imaging scanner as set forth in claim **13**, wherein the magnetic field gradient coil windings **(70, 72, 74, 76)** when energized produce one or more magnetic field gradients imposed on an associated generally horizontal magnetic field at least in the imaging volume **(16)**, the magnetic field gradient coil windings including at least:

a first set of windings **(102, 104)** that when energized produce a first magnetic field gradient **(106)** oriented at a 45° angle to the horizontal; and

a second set of windings **(112, 114)** that when energized produce a second magnetic field gradient **(116)** oriented at a 45° angle to the horizontal and oriented transverse to the first magnetic field gradient **(106)**.

18. The imaging scanner as set forth in claim **13**, wherein the second length (L_{lower}) spanned by coil windings of the lower section **(42)** is greater than the bore length (L_{bore}).

19. The imaging scanner as set forth in claim **13**, wherein the radio frequency coil **(28)** includes:

a generally planar lower section **(28_1)** disposed in the imaging subject support section **(20)** of the housing **(10)**; and

an arcuate upper section **(28_2)** that together with the lower section **(28_1)** define a radio frequency coil bore contain the imaging volume **(16)**.

20. A method of magnetic resonance imaging, the method comprising:

generating a main magnetic field through a subject receiving bore **(14)**;

generating magnetic field gradients across the bore **(14)** with a combination of (i) upper gradient coils **(70, 74)** that have a first longitudinal length (L_{upper}) shorter than a diameter (D_{bore}) of the bore **(14)** and (ii) lower gradient coils **(72, 76)** that have a second longitudinal length (L_{lower}) longer than the diameter of the bore **(14)**.